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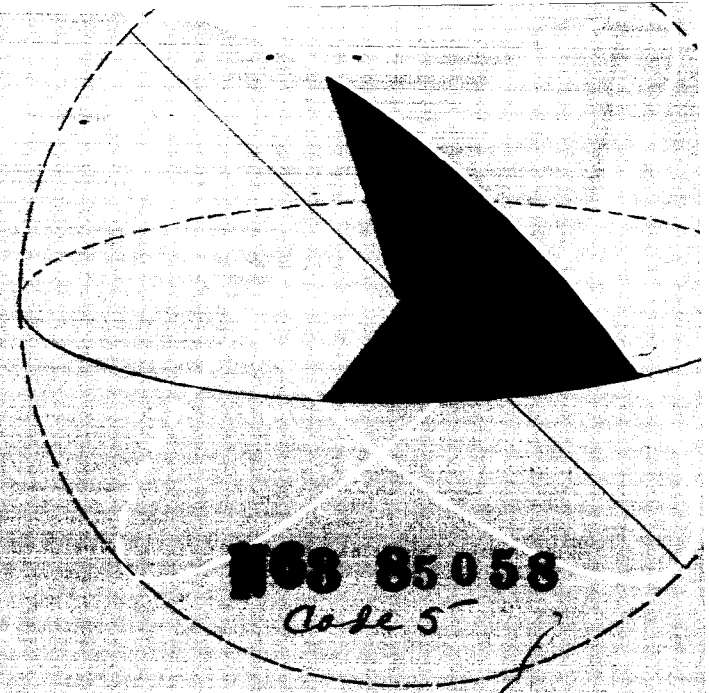

LITERATURE SEARCH NO. 195
MEASURING MAGNETIC FIELDS

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MARCH 3, 1960

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY

National Aeronautics and Space Administration
(NASA Contract No. NASw-6)

ASTRONAUTICS INFORMATION

LITERATURE SEARCH NO. 195

METHODS OF MEASURING MAGNETIC FIELDS

Edda Barber

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JET PROPULSION LABORATORY
California Institute of Technology
Pasadena, California
March 3, 1960 24 p

FOREWORD

The purpose of this literature search is to supply references on methods of measuring magnetic fields from a space vehicle. Interest was expressed for certain specific methods, and therefore, the search has been divided as follows: I. A general section in which magnetometers using the Hall effects, peaking strips, the generator principle, and various fluxmeters are included; II. Magnetic resonance methods; III. Moving coil magnetometers; and IV. Airborne magnetometers.

This search is unclassified, and classified reports have been included only if the title and abstract are unclassified in accord with the ASTIA Technical Abstracts Bulletin.

The following sources have been consulted:

ASTIA,
Astronautics Information/Abstracts
Astronautics Information/Survey
The Literature of Space Science and Exploration
The Engineering Index (EI), 1957-1958
Applied Science and Technology (AS&T), 1959
Physics Abstracts (PA), 1958-1959
Nuclear Science Abstracts (NSA), 1958-1959
Miscellaneous sources

PREFACE

The technical staff of the Jet Propulsion Laboratory library is engaged in an extensive literature searching program covering subjects selected by the Laboratory engineers and designed to meet their individual needs. Searches considered to be of interest to persons working in the field of astronautics will be published for distribution to interested organizations.

CONTENTS

I. GENERAL

A. Reports

1. THE ELECTRON MULTIPLIER AS AN INDICATOR FOR A WEAK MAGNETIC FIELD
Krasnogorskaya, N. V.
Air Technical Intelligence Center,
Wright Patterson AFB, Ohio
ATIC-293921, 1957, Translation F-TS-9091/V
of Zhurnal Tekhnicheskoy Fiziki, v. 20,
pp. 1257–1266, 1950 (AD 137,550)

2. THE CONSTRUCTION OF LAMONT-TYPE MAGNETOMETERS
Benkova, N.
Air Technical Intelligence Center,
Wright Patterson AFB, Ohio
ATIC-293904, 1957, Translation F-TS-10003/V
of *Uchenye Zapiski Kazanskogo Gosudarstuennogo Universiteta*, v. 96, pp. 59–65, 1936 (AD 137,560)

3. A FLUXMETER ON A STRING AXIS
Groshevoy, G. V.
Air Technical Intelligence Center,
Wright Patterson AFB, Ohio
ATIC-262918, 1950, Translation F-TS-8972/III of
Akademiya Nauk SSSR, Trudy Geofizicheskii Instituta, v. 12, pp. 77–79, 1950 (AD 120,711)

The article describes an attempt to use the string axis in a fluxmeter. The operating principles of the string axis in this instrument are briefly considered. The advantages and disadvantages of a string axis as opposed to core supports are pointed out. At the end of the article the results of tests of an experimental model of a fluxmeter with a string axis are presented. The deductions from the results of the experiment are set forth. (ASTIA)

4. SELECTED ARTICLES (FROM) RADIO-TEKHNIKA, VOL. 10, NO. 4, 1955, PAGES 7–35
Air Technical Intelligence Center,
Wright Patterson AFB, Ohio
ATIC-224440, Translation F-TS-8641/V,
1956 (AD 146,955)

5. THE POSSIBLE APPLICATION OF MAGNETOMETRIC METHODS TO THE QUESTION OF EARTHQUAKE INDICATIONS
Kalashnikov, A. G.
Air Technical Intelligence Center,
Wright Patterson AFB, Ohio
ATIC-293914, 1957, Translation F-TS-10006/V of
Akademiya Nauk SSSR, Trudy Geofizicheskii Instituta, v. 152, pp. 162–180, 1954 (AD 140,547)

This paper shows the theoretical possibility of using the variations in the secular march of the magnetic field and the variations in the magnetic properties of rocks during their deformation as indicators of earthquakes, and points out facts on the correlation between magnetic and seismic phenomena. On the basis of an experimental study of the magnetic susceptibility of rocks under unilateral compression, the author calculates the order of the seismomagnetic effect. (ASTIA)

6. STUDY OF MAGNETIC AND GRAVITATIONAL FIELD ANOMALIES BY ANALOG METHODS, USING AN AUTOMATIC FIELD MAGNETOMETER
Kalashnikov, A. G.
Air Technical Intelligence Center,
Wright Patterson AFB, Ohio
ATIC-262900, 1954, Translation F-TS-8954/V of
Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, no. 6, pp. 546–553, 1954
(AD 120,703)

An analog method for studying anomalies of the magnetic and gravitational fields is given; the principle

of similitude for modeling the fields is stated; an instrument, a recording field magnetometer, designed for these measurements in modeling the fields, is described; and a few examples of the practical use of the field meter are presented. (ASTIA)

7. **THE USE OF A FLUXMETER TO DETERMINE THE PERFORMANCE INDEX OF ROCKET MOTOR (U)**
Price, J. R.
Armament Research and Development Establishment, Great Britain
ARDE Memo (P)11/56 (Confidential)
April 1956 (AD 104,303)

This report describes the use of a fluxmeter to obtain the total impulse of a rocket motor without the necessity of taking photographic records and integrating them. The fluxmeter, in conjunction with a carbon resistor pressure gauge forming one arm of a bridge circuit, will give direct readings, which, when multiplied by a predetermined factor, will give the total impulse direct. The method is especially applicable to rockets burning at a steady pressure for about 3 sec or more. (ASTIA)

8. **SOME MEASUREMENT OF THE MAGNETIC FIELD PRODUCED BY RIDGED POLE PIECES**
Smith, P. F.
Atomic Energy Research Establishment, Great Britain
Memo GP/M195, 1956

9. **AN IMPROVED PERMALLOY STRIP MAGNETOMETER**
Russell, F. M. and Wilkins, H. A.
Atomic Energy Research Establishment, United Kingdom Atomic Energy Authority, Research Group, Great Britain
October 1958

A modified magnetometer head using a permalloy strip as the sensitive element is described which is capable of measuring magnetic field strengths up to 300 gauss. Two methods of use are described. One is fully automatic and is useful for the rapid scanning of fields, while the other can be used for the measurement of the absolute value of the field strength by making spot measurements to an accuracy of better than ± 10 milligauss. (*NSA*, 1959)

10. **PRECISION MEASUREMENT OF MAGNETIC INDUCTION WITH BISMUTH WIRE**
Keller, H. B.
California, University of, Berkeley, Calif.
Contract W7405-eng-48, UCRL-2249, June 9, 1953 (AD 14,855)

The resistance of Bi wire is a function of temperature and magnetic induction, varying inversely with temperature. At low temperatures the resistance may be taken as a measure of magnetic induction. The magnetic induction may then be plotted directly vs. any convenient coordinate. (ASTIA)

11. **MAGNETOMETER**
Schmitt, O. H.
Commerce Dept., Patent Office, Washington, D. C.
Patent No. 2,721,974, October 25, 1955

The system claimed is based on a magnetometer system similar to that of Document No. 58081. The reference signal is in phase with the sensitive output of the filter. A discriminator is connected to receive the sensitive output and the reference signal, and to produce signals proportional to the sum and difference of the filter output and the reference signal. An output signal is produced which is proportional to the difference between the sum and difference signals.

12. **PHASE-SHIFT MAGNETOMETER**
Schmitt, O. H.
Commerce Dept., Patent Office, Washington, D. C.
Patent No. 2,713,661, July 19, 1955

The phase-shift magnetometer system claimed includes a bar magnetometer; means for driving it cyclically; a filter to isolate sensitive components of double the drive frequency; means for generating a reference signal of twice the driving frequency and phase quadrature with the sensitive output of the filter, and at least three times the amplitude of the signal component at the output of the filter due to applied field; an amplitude-limiting amplifier of constant phase shift to receive the filter output and amplify the sum of the reference signal and the output signal of the filter; and means for comparing the phase of the amplifier output with that of the reference signal.

13. THE LOOP ANTENNA AS A PROBE IN ARBITRARY ELECTROMAGNETIC FIELDS
King, R.
Harvard University, Cruft Lab., Cambridge, Mass.
Nonr-186626, TR 262, May 1, 1957 (AD 133,490)

A study is made of the properties of an electrically small rectangular loop antenna as a probe for measuring the magnetic part of an arbitrary electromagnetic field. The analysis begins with the receiving properties of a loop in a linearly polarized incident plane wave. The existence of dipole modes in the loop is demonstrated and the failure of conventional methods of analysis to take account of them is discussed. The use of slotted shields is considered as well as the problem of measuring the magnetic component of an elliptically polarized electromagnetic field. (ASTIA)

14. IMPROVEMENTS IN THE DESIGN OF THE FIVE-STRING PENDULUM MAGNETOMETER
Nowlin, C. H.
Harvard University, Gordon McKay Lab. of Applied Science, Cambridge, Mass.
Scientific Report 14, AFCRC TN 19(604)1084, September 10, 1958 (AD 160,863)

15. MEASUREMENT OF MAGNETIC FIELD GRADIENTS BY THE HALL EFFECT
Redin, R. D. and Danielson, G. C.
Iowa State College, Ames Lab., Ames, Iowa
Contract W7405-eng-82, ISC-685, December 1955 (AD 102,367)

A magnetic field gradient measuring device, which uses the Hall effect in germanium, has been constructed. The field sensitive element is a bar of germanium 1 mm by 1 mm by 12 mm with two sets of Hall leads attached 2 mm either side of its center. One hundred cycle alternating current flows in the long direction of the bar. In a magnetic field two 100-cycle Hall voltages are obtained. These voltages, which are proportional to the magnetic field strength at two points of the field 4 mm apart, are subtracted to give an output directly proportional to the magnetic field gradient. The instrument will also measure field strengths and relative gradients. (ASTIA)

16. ELEMENTS OF INSTRUMENTATION PART III. MAGNETIC TRANSDUCERS
Lion, K. S. and Berkowitz, D. A.
Massachusetts Institute of Technology, Applied Biophysics Lab., Instrumentation Lab., Cambridge, Mass.
N5ori-07882, NR 011-705, TR-4, March 1956

This report deals with magnetic field transducers or magnetic field sensing elements. Sections covered in this report are: induction systems; instruments based upon magnetic effects on moving charges; transducers based on permeability variation; nuclear magnetic resonance systems; and indirect systems.

17. ELECTRON-BEAM MAGNETOMETER
Leder, L. B. and Coleman, J. W.
National Bureau of Standards, Office of Basic Instrumentation, Washington, D. C.
NAonr-144-52, NBS 2381, March 31, 1953 (AD 36,696)

18. A METHOD OF MEASURING THE DYNAMIC PROPERTIES OF CORE MATERIAL
Patrick, J. D.
Naval (Avionics Facility), Indianapolis, Ind.
NAVORD 940-1456, October 6, 1954 (AD 122,758)

Basic circuits and theory are given of a method developed at the Naval Ordnance Plant, Indianapolis, for the measurement of the dynamic properties of magnetic cores. This method is identified in this report as the AC Permeability Analyzer. (ASTIA)

19. EVALUATION OF COVERMETER
Stoll, R. W.
Naval Civil Engineering Research and Evaluation Laboratory, Port Hueneme, Calif.
TN N-223, June 17, 1955 (AD 108,250)

The Covermeter affords a non-destructive means of measuring the depth to, and location of, reinforcing steel in concrete. The instrument as received displayed only a fair degree of accuracy. The device was recalibrated, taking into account diameter of reinforcement and instrument power source. The modified instrument measured depths up to 1 in. cover to an accuracy of 0.1 in. for reinforcement of 0.1 in. diam. or larger, and is capable of measuring depths between 1 and 1½ in. to an accuracy of 0.2 in. (ASTIA)

20. MATHEMATICAL DETERMINATION OF MAGNETIC FIELD INTENSITIES IN THE VICINITY OF THE RUSKA ASTATIC MAGNETOMETER
Cohen, S. O.
Naval Gun Factory, Washington, D. C.
TR NGF-T-65-53, June 15, 1954 (AD 34,930)

Values of magnetic field intensity were computed in the neighborhood of the magnetometer as a preliminary to an extensive series of tests on magnetic susceptibility. (ASTIA)

21. MICROWAVE MAGNETOMETER
Allen, P. J.
Naval Research Laboratory, Washington, D. C.
NRL Reprint 96-52, 1952, Reprint from NRL Progress Report, pp. 5–7, September 1952 (AD 12,327)

22. MEASUREMENT OF FIELD DISTRIBUTION IN THE AIR GAP OF A D-C MOTOR THROUGH THE HALL EFFECT
Kuhrt, F. and Braunersreuther, E.
Murray, R. C., Translator
Royal Aircraft Establishment, Great Britain
JSRP Control No. 581042, Translation 735 of ETZ-A 77, pp. 578–581, 1956, May 1958 (AD 201,308)

23. A RECORDING MAGNETIC VARIOMETER
Meek, J. H. and Hector, F. S.
Saskatchewan University, Canada
DRB Reprint 591, March 7, 1955 (AD 104,376)
Reprint from *Canadian Journal of Physics*, v. 33, pp. 364–368, 1955

The circuit and detecting head of an electronic recording magnetic variometer are described. The apparatus will give continuous and immediately observable values of variations of magnetic field as small as 10^{-5} oersted, if necessary. (ASTIA)

24. (CLASSIFIED TITLE)
Mathias, J.
Varian Associates, Palo Alto, Calif.
NObs-72028, Engineering Report 175–8, Engineering Progress Report on Phase 2 (Confidential) January–February, 1957 (AD 147,925)

25. MAGNETIC VELOCITY INDICATOR FEASIBILITY STUDY
Rempl, R.
Varian Associates, Palo Alto, Calif.
AF 33(616)5200, Engineering Report 207-1, QR 1, May 1–July 31, 1957 (AD 149,890)

26. SHIPBOARD MAGNETIC NAVIGATIONAL SYSTEMS (U)
Mansir, D. L.
Varian Associates, Palo Alto, Calif.
NObs-72174, Engineering Report 191–8, Final Report on Phase 2 (Confidential) September 1957 (AD 154,343)

27. DYNAMIC AND STATIC MEASUREMENTS OF STRONGLY INHOMOGENEOUS MAGNETIC FIELDS
De Raad, B.
Gravenhage, Netherlands
Thesis, Excelsior, 1958

The techniques and instruments used to measure the magnitude and distribution of the flux density in strongly inhomogeneous fields that vary in time are described. The results of the magnetic measurements are given. (*NSA*, 1959)

B. Periodicals

28. METHODS OF MEASURING STRONG MAGNETIC FIELDS
Symonds, J. L.
Reports on Progress in Physics, v. 18, pp. 83–126, 1955

Descriptions which are briefly theoretical and essentially practical are given of a number of the techniques of magnetic field measurement used or developed in the period of about twenty years since the last review of the subject. Particular attention is given to the application of the phenomenon of magnetic resonance while other subjects discussed are magneto-resistance, Hall effect, peaking strips, the generator principle and various fluxmeters. The uses which are made of the force exerted on a current-carrying conductor in a magnetic field are given though some of these are not, strictly speaking,

field measurements. The measurement of the position of the magnetic median plane of a magnet is discussed. The last paragraphs are devoted to a description of a few methods which do not find very wide application. A list of about 150 references is appended. These are classified in groups under the heading of each particular method. (*NSA*, 1958)

29. A NEW METHOD OF MEASUREMENT OF THE MAGNETIC PROPERTIES OF THIN FILMS BY MEANS OF THE FARADAY EFFECT
Reimer, L.
***Zeitschrift für Naturforschung*, v. 11a, no. 7, p. 611, July, 1956 (in German)**

The rotation ϕ, of the plane of polarization was measured as a function of field strength H for a Ni film of thickness 450 Å evaporated on glass. To avoid large demagnetizing effects H was applied parallel to the film surface and the incident light at 45 deg to the normal. The (ϕ, H) curve is a hysteresis loop with coercive force about 30 oersted. (*PA*, 1957)

30. ON CERTAIN POSSIBILITIES OF MEASURING MAGNETIC FIELD STRENGTH USING THIN-FILM HALL-E. M. F. PROBES PREPARED FROM HgSe, Hg Te, AND THEIR SOLID SOLUTIONS
Elpathsvskaya, O. D. and Regel, R. A. R.
***Zhurnal Tekhnicheskoi Fiziki*, v. 26, no. 11, pp. 2432–2438, 1956 (in Russian)**

31. MEASUREMENT OF THE FIELD OF MAGNETS OF ACCELERATORS WITH STRONG FOCUSING
Grekov, N. N., Ryabov, A. P., and Goldin, L. L.
***Pribory i Tekhnika Eksperimenta*, no. 2, pp. 29–37, 1956 (in Russian)**

32. THE MEASUREMENT OF INHOMOGENEOUS MAGNETIC FIELDS IN NARROW GAPS
Knizak, J.
***Acta Physica Austriaca*, v. 10, no. 3, pp. 185–189, 1956 (in German)**

Apparatus making use of the potential difference developed, in the presence of a magnetic field, between two electrodes in a stream of mercury has been developed for the measurement of the magnetic field in a volume of 1 mm^3. (*PA*, 1957)

33. BEITRÄGE ZUR THEORIE DES FLUSSMESSERS
Kaler, H. von
***Deutsche Elektrotechnik*, v. 11, no. 2, pp. 75–78, February 2, 1957**

Contributions to the theory of fluxmeters; equations of motion integrated in three approximations; measurements based on switch clock and normal mutual inductivity are contrasted with measurements using condenser discharge; ranges for time constant and external resistance, with indication tolerance of plus or minus 2% can be determined. (*EI*, 1957)

34. CHANGE IN PERMANENT MAGNET POLE STRENGTH
Briscoe, E. M.
***Electrical Energy*, v. 1, no. 11, pp. 340–343, July 1957**

Magnet balance developed for detecting changes in stability of permanent magnets used in measuring instruments and allowing very precise magnetic measurements to be carried out; findings in long-term behavior of permanent magnets are equally applicable in design of other electronic equipment. (*EI*, 1957)

35. CONTINUOUS MEASUREMENT AND RECORDING OF VARIABLE MAGNETIC FIELDS BY THE PME EFFECT
Mette, H.
***Review of Scientific Instruments*, v. 28, p. 1096, December 1957**

36. DIE SCHNELLE UND GENAUE MESSUNG DER KOERZITIVKRAFT
Foerster, F.
***Archiv für Technisches Messen*, v. 254, 255, pp. 65–66, March 1957, pp. 87–90, April, 1957**

Rapid and accurate measurement of coercive force; instrument described has high measuring accuracy, measuring time of few seconds, complete insensitivity toward ground and interference fields, particularly high sensitivity for measuring coercive force of very small samples. (*EI*, 1957)

37. A DEVICE FOR THE PRECISION MEASUREMENT OF AN INHOMOGENEOUS MAGNETIC FIELD
Backstrom, G.
Nuclear Instruments, v. 1, pp. 253–258, September 1957

A generator device has been constructed for measuring the field of a B spectrometer, having a gradient of 1% per cm and a field range of 10–300 gauss. A sensitivity of 1:10^5 has been obtained. (*NSA*, 1958)

38. AN ELECTRICAL RECORDING MAGNETOMETER
Serson, P. H.
Canadian Journal of Physics, v. 35, no. 12, pp. 1387–1394, December 1957

An instrument for recording at a fixed station variation in three orthogonal components of the Earth's magnetic field is described. (*PA*, 1958)

39. A MAGNETICALLY SCREENED MEASURING CHAMBER USING MAGNETICALLY BIASED TRANSFORMER-SHEET
Albach, W.
Zeitschrift für Angewandte Physik, v. 9, no. 3, pp. 111–115, March 1957 (in German)

40. A NEW METHOD OF MEASURING MAGNETIC FIELD STRENGTH
Pikus, G. E. and Sorokin, O. V.
Zhurnal Teknicheskoi Fiziki, v. 27, no. 11, pp. 2647–2651, 1957 (in Russian)

The new method presented is based on the effect of the variation of the concentration of current carriers in a thin semiconducting plate through which current passes in a magnetic field. The given theory shows that the method may serve for measuring fields from 5×10^3 to 10^{-5} oersted, provided the relation between the voltage measured and the magnetic field strength is linear. (*PA*, 1959)

41. NOTE ON PRODUCTION OF STRONG MAGNETIC FIELDS OF SHORT DURATION AND MEASUREMENT OF THEIR INTENSITY
Piekara, A., Maleck, J., Surma, M., and Gibalewica, J.
Proceedings of the Physical Society, London, Series B, v. 70, Part 4, pp. 432–434, April 1957

42. ON THE DESIGN OF MAGNETIC MODULATION DETECTORS FOR MAGNETIC FIELD INTENSITY (MEASUREMENT)
Rozenblat, M. A.
Elektrichestvo, no. 7, pp. 24–31, 1957 (in Russian)

The type of detector studied consists of an inductor with a high-permeability open core which is placed in the field to be measured. A sinusoidal m.m.f., large enough to saturate the core, is superposed on the unknown field and from the wave-shape of the resultant e.m.f. the unknown intensity can be derived. Formulae are derived for various design considerations, including sensitivity, physical dimensions and core properties. Tables and graphs indicate good agreement between calculated and measured data. (*PA*, 1958)

43. PRINCIPLE FOR NULL DETERMINATION OF MAGNETIZATION AND ITS APPLICATION TO CRYOGENIC MEASUREMENTS
Arrott, A. and Goldman, J. E.
Review of Scientific Instruments, v. 28, no. 2, pp. 99–102, February 1957

Use of sample in uniform magnetic field, uniformity of which is not affected by sample: direct measurement of magnetization by proper current through small pitch fine wire coil wound on cylindrical specimen to restore uniformity of field: principle used in apparatus for measurements of magnetizations from liquid helium temperatures. (*EI*, 1957)

44. ÜBER DIE MESSUNG KLEINSTER MAGNETISCHER FELDER MIT HALLGENERATOREN
Hieronymus, H. and Weiss, H.
Siemens Zeitschrift, v. 31, no. 8, pp. 404–409, August 1957

Measurement of very small magnetic fields by means of Hall generators; using a "Multizet" instrument for indication of Hall potential, it is possible to obtain sensitivity in range of 5 mv without amplifier. (*EI*, 1957)

45. CONSTRUCTION OF A TRANSLATION BALANCE FOR THE MEASUREMENT OF MAGNETIC SUSCEPTIBILITIES AT LOW TEMPERATURES
Cohen, J.

Comptes rendus hebdomadaires des séances de l'académie des sciences, v. 246, no. 25, pp. 3425–3427, June 23, 1958 (in French)

Describes a compact balance suitable for use at low temperatures and in a controlled atmosphere, and with a sensitivity for susceptibility measurements of 5×10^{-11} e.m.u. (*PA*, 1958)

46. DECADE FLUX LINKAGE GENERATORS FOR CALIBRATING FLUXMETERS AND BALLISTIC GALVANOMETERS

Palmer, T. M.

Journal of Scientific Instruments, v. 35, pp. 139–142, April 1958

Description of two versions of self-contained instrument for calibrating fluxmeters and ballistic galvanometers: known constant flux change is produced by reversing primary current in saturated inductor; desired linkage is then obtained by switching appropriate number of secondary turns into circuit: two saturable inductors provide total flux linkage change of 11.11×10^6 Maxwell turns in four decades. (*EI*, 1958)

47. DIRECT QUARTZ CRYSTAL CONTROL OF A LOW-LEVEL POUND-KNIGHT-WATKINS SPIN MAGNETOMETER

Blume, R. J.

Review of Scientific Instruments, v. 29, no. 7, pp. 544–547, July 1958

A quartz crystal is placed in the feedback path of the marginal oscillator. Magnetometer operation at an r.f. level as low as 100 μv across the sample coil, equivalent to an r.f. field of about 5 μG was obtained. A magnet servo based on the crystal controlled magnetometer was discussed.

48. AN ELECTRODELESS METHOD FOR THE MEASUREMENT OF ELECTROLYTIC CONDUCTIVITY AND MAGNETIC SUSCEPTIBILITY

Meyers, W. R.

Journal of Scientific Instruments, v. 35, no. 5, pp. 173–175, May 1958

Simultaneous measurement of electrolytic conductivity and magnetic susceptibility is achieved by observing the changes in output voltage of a transformer when its air core is filled with a specimen. Conductivity measurements for strong electrolytes were obtained, in which departures from accepted values are less than 0.07 mho m^{-1} in the range from 1 to 30 mho m^{-1}. The magnetic measurements generally have less precision, and errors of 2% occur for susceptibilities of the order of 10^{-11} H/m. (*PA*, 1958)

49. IMPROVED TORQUE MAGNETOMETER

Byrnes, W. S. and Crawford, R. G.

Journal of Applied Physics, v. 29, pp. 493–495, March 1958

50. MAGNETIC ANISTROPY MEASUREMENT WITH AN OSCILLATION MAGNETOMETER

Macdonald, J. R.

British Journal of Applied Physics, v. 9, no. 3, pp. 116–119, March 1958

A method of using an oscillation magnetometer to determine magnetic anisotropy factors in the plane of a thin disk-shaped sample lying in the X–Z-plane is described. Both the saturation magnetization, M_0 and the factor $(N_x - N_z) M_0$ may be obtained independently. N_x, N_y and N_z are demagnetization factors which include all contributions to magnetic anisotropy such as those arising from stress magnetocrystalline anisotropy and shape. These results are correlated with previous work on a somewhat different type of oscillation magnetometer used to determine $(N_y - N_z) M_0$ and it is shown that a correction must be applied for both types of magnetometer when the oscillation amplitude exceeds a degree or two. Finally, it is shown that the oscillation magnetometer can be employed to determine the details of any angular dependence of magnetic anisotropy in the plane of the sample if such anisotropy is sufficiently large. These measurement techniques are particularly applicable to the determination of any dependence of M_0 on film thickness in thin ferromagnetic evaporated films, and to the determination of magnetic anisotropy in thin films evaporated and/or annealed in a magnetic field. (*PA*, 1958)

51. MAGNETIC GAUGE UTILIZING MAGNETRON EFFECT

Fulop, W.

Journal of Scientific Instruments, v. 35, no. 2, pp. 52–55, February 1958

Cutoff region of magnetron diode is shown to be accurate, through relative measure of magnetic field; this

magnetron effect is utilized to calibrate subminiature diode to serve fluxmeter; only simple auxiliary apparatus is required and accuracies greater than 1% are easily obtained. (*EI*, 1958)

52. MAGNETIC MEASUREMENTS ON SOME PRECIPITATING SYSTEMS
Berkoyitz, A. E. and Flandres, P. J.
***Journal of Applied Physics*, v. 29, pp. 314–316, March 1958**

53. MAGNETIC MEASUREMENTS WITH THE BRIDGED—T NETWORK
Choudhury, J. L. and Sen, P. C.
***Journal of Scientific Instruments*, v. 35, pp. 145–146, April 1958**

54. MAGNETOMETER IS MORE SENSITIVE
***Electronics*, v. 31, p. 96 ff., August 1, 1958**

55. MAGNETOMETER MAKES CONTINUOUS MEASUREMENTS
Voelker, F.
***Electronics*, v. 31, pp. 152–154, March 14, 1958**

Instrument designed for magnetic measurements which meets requirements of 0.1% accuracy in fields of 10 to 100 gauss and allows for continuous monitoring of field to follow automatic plotting against probe position: probe design varies with application; electronic circuit is closed circuit servo loop, with internal r.f. excitation to bring magnetic field to knee of B-H curve of probe. (*EI* 1958)

56. A MASS SPECTROMETER MASS MARKER
Beynon, J. H. and Clough, S.
***Journal of Scientific Instruments*, v. 35, no. 8, pp. 289–291, August 1958**

An instrument has been constructed which utilizes the galvanomagnetic effect in bismuth to measure the field strength of a mass spectrometer magnet, and hence to determine the masses of peaks as they occur when the spectrum is scanned by variation of the magnetic field strength at constant accelerating voltage. The bismuth coil is mounted between the pole-pieces of the magnet and the instrument marks on the mass spectrum a series of fifty mass calibration points at predetermined values of bismuth resistance and hence of magnetic field. Masses can be determined with the instrument to ± 0.05 mass unit in the range up to mass 200 and to accuracy of $\pm 0.025\%$ above this range. (*PA*, 1958)

57. MEASUREMENT OF MAGNETIC FIELD GRADIENTS BY THE HALL EFFECT
Redin, R. D. and Danielson, G. C.
***Iowa State College Journal of Science*, v. 32, pp. 463–469, February 15, 1958**

A magnetic field gradient measuring device which uses the Hall effect in germanium has been constructed. The usefulness of the instrument is still uncertain because of errors caused by excessive field dependence of the gradient voltage. (*NSA*, 1958)

58. MEASUREMENT OF THE GYROMAGNETIC EFFECT WITH MACROSCOPIC AND MICROSCOPIC SUPERCONDUCTING LEAD SPHERES
Doll, R.
***Zeitschrift für Physik*, v. 153, no. 2, pp. 207–236, 1958 (in German)**

59. MEASUREMENTS OF HETEROGENEOUS CONSTANT MAGNETIC FIELDS
Ulyanov, G. K. and Vinogradov, K. N.
***Pribory i Tekhnika Eksperimenta*, no. 5, pp. 102–104, September 1958 (in Russian)**

The apparatus for measuring sharply heterogeneous constant magnetic fields employs a wire transducer. Curves of dependence of magnetic-field distribution at the magnet-system gap on the pole-piece angle of deflection are plotted. (*NSA*, 1959)

60. MEASUREMENT OF MAGNETIC FIELDS IN ALUMINUM REDUCTION FURNACES
Kent, J. H.
***Journal of the Electrochemical Society*, v. 105, pp. 603–607, October 1958**

61. NEW INSTRUMENTS FOR MAGNETIC STUDIES; TORQUE MAGNETOMETERS
***Westinghouse Engineer*, v. 18, p. 190, November 1958**

62. A PERMEAMETER CONTROLLER FOR MAGNETIC MEASUREMENTS
Swan, M. J.
Journal of Scientific Instruments, v. 35, no. 9, pp. 344–346, September 1958

63. PORTABLE MAGNETIC FIELD AND GRADIENT METER
Thoburn, W. C.
Review of Scientific Instruments, v. 29, pp. 990–992, November 1958

64. REMARKS ON MEASURABILITY OF ELECTROMAGNETIC FIELDS
Heber, G.
Il Nuovo Cimento, v. 7, no. 5, pp. 677–684, March 1, 1958

65. TEMPERATURE-REGULATED BISMUTH RESISTOR FOR MAGNETIC-FIELD MEASUREMENTS
Dols, C. G., Skiff, E. W., and Watson, P. G.
Review of Scientific Instruments, v. 29, no. 5, pp. 349–354, May 1958

The magnetoresistance effect of the metal bismuth has been used in measuring magnetic induction for many years. This paper describes significant features of the electrical and mechanical design of an electrically temperature-regulated resistor assembly and associated equipment. Commercial ductile bismuth wire was successfully used in a small probe. Useful resolution of 2 gauss in fields above 5000 gauss was readily attained. Limitations and advantages of bismuth resistors as devices for measuring magnetic induction are discussed briefly. Some data from the use of the first units are presented. (*PA*, 1958)

66. THE USE OF ELECTRON DIFFRACTION FOR MAGNETIC ANALYSIS
Yamaguchi, S.
Naturwissenschaften, v. 45, no. 1, pp. 7–8, 1958 (in German)

This effect can be exploited in the study of ferromagnetic materials in electron diffraction instruments.

67. ACCURATE MAGNETIC FIELD AND FIELD GRADIENT MEASURING INSTRUMENT FOR DYNAMIC LOW FIELDS IN A SYNCHROTRON MAGNET
Nysater, H. M.
Nuclear Instruments and Methods, v. 4, pp. 44–49, January 1959

Two biased peaking strips have been combined into a differential magnetic probe. The instrument, when applied to the CEA magnets, confirmed the feasibility of an injection field as low as 25 gauss, although at the magnet ends sharp peaks occur in the field and gradient distributions, apparently a remnant field contribution.

II. MAGNETIC RESONANCE METHODS

A. Reports

68. A NUCLEAR RESONANCE DETECTOR AND MAGNETIC FIELD STABILIZER
Gray, D. A.
Atomic Energy Research Establishment, Great Britain
July 1956 (AD 116,937)

Constructional details are given of a nuclear resonance detector which enables magnetic fields of 1,000 to 8,000 gauss to be measured to 0.01%. The signal from such a detector may be used to stabilize the field of an electromagnet to 0.01% and particular arrangements are described which permit the stabilization of: a small electromagnet of 1-in. gap, 8-in. diam. pole face, power 500 watts and field 1,000 to 1,500 gauss; a larger variable gap magnet, pole face diameter up to 20 in., power 3 kw and field up to 8,000 gauss. (ASTIA)

69. A BRIDGED TEE DETECTOR FOR NUCLEAR MAGNETIC RESONANCE
Waring, C. E. and Spencer, H.
Connecticut University, Storrs, Conn.
N6ori-216, T.O. 1, Technical Report, August 13, 1951 (AD 7,725)
Reprint from *Review of Scientific Instruments*, v. 23, pp. 497–498, September 1952

B. Periodicals

70. HIGH ALTITUDE MEASUREMENTS OF THE EARTH'S MAGNETIC FIELD WITH A PROTON PRECESSION MAGNETOMETER

Cahill, L. J., Jr. and Van Allen, J. A.
***Journal of Geophysical Research*, v. 61, no. 3, pp. 547–558, September 1956**

A nuclear free-precession magnetometer of the Packard-Varian type was built and used for the precise measurement of the Earth's magnetic field (scalar magnitude of total field vector) at high altitudes. The instrumentation, including the magnetometer head, amplifier, and radio telemetering transmitter, was carried to 100,000-ft altitude by a plastic Skyhook balloon. Signals were transmitted to a fixed ground station at 1-min intervals and the nuclear precession frequency was determined by standard frequency measuring techniques. Satisfactory signals were received until 2.5 hr after launching, at which time the balloon was near the radio horizon, approximately 200 mi from the ground station. The data showed a decrease in magnetic field intensity with altitude, as well as large variations in intensity with geographical position. (*PA*, 1958)

71. NUCLEAR RESONANCE APPARATUS FOR RELATIVE MEASUREMENTS OF A MAGNETIC FIELD

Vrscaj, S.
***"J. Stefan" Institute Reports*, v. 3, pp. 95–97, October 1956 (in German)**

The apparatus served for relative measurement of magnetic field with larger magnet surfaces and used the interference frequency between 2 samples for determination of field strength differences at the test points. Two tenths cm^3 of ordinary water with 0.5% ferric nitrate served as a test sample. At 5000 gauss the proton resonance frequency amounts to 21.3*M* Hz. At a one gauss difference in magnetic flux density, the frequency differential is 4260 Hz. The test range was 900 to 5000 gauss, thus the inhomogeneity of the fields could not exceed 3 gauss/cm. (*NSA*, 1957)

72. THEORETICAL AND EXPERIMENTAL STUDY OF THE FORMS OF THE CURVES OBTAINED IN NUCLEAR RESONANCE

Rocard, J. M.
***Archives des Science, Société de la Physique et d'histoire Naturelle de Genève*, v. 9, no. 3, pp. 237–261, 1956 (in French)**

A discussion of Bloch's equation and their solutions as ΩT_2 is $> = <$ 1, where Ω is the low frequency of the modulation field. T_2 is measured for $Fe(NO_3)$ solutions down to N/1000 where $T_2 = 5.5 \times 10^{-2}$ sec. The Earth's magnetic field at Jussy is measured to be 0.4522 ± 0.0001 G essentially by finding the additional field required to give resonance at exactly 3 kc/s. (*PA*, 1957)

73. FIELD STABILIZER FOR HIGH RESOLUTION NUCLEAR MAGNETIC RESONANCE

Primas, H. and Guethard, H. H.
***Review of Scientific Instruments*, v. 28, no. 7, pp. 310–314, July 1957**

System in which voltage induced by field variations in suitably located coils is amplified by galvanometer amplifier, integrated, and fed back to system of coils biasing field; stabilizer allows measurement of nuclear magnetic resonance signals with resolution of 10^8 under field conditions, independent of fluctuations produced by temperature variations and stray fields; achievable time stability is $1:10^8$. (*EI*, 1957)

74. MEASUREMENT OF THE MAGNETIC FIELDS BY THE METHOD OF PROTON MAGNETIC RESONANCE

Zhernovoi, A. L., Latyshev, G. D., and Sergeev, A. G.; Melnick, I., Translator
***Pribory i Tekhnika Eksperimenta*, no. 2, pp. 60–62, 1957**

An apparatus is described which permits a measurement of the intensity of a magnetic field in all the ranges necessary to spectroscopy. The precision of the measurements relative to the magnetic field, determined by resonance according to the length of the absorption curve, is 10^{-4} in the zone from 35 to 100 oersteds and 2×10^{-5} in the zone from 100 to 400 oersteds. The verification of the precision of the measurements was made by reproduction of the positions of the maxima of the conversion rays. (*NSA*, 1959)

75. MEASUREMENT OF MAGNETIC FIELDS BY MEANS OF NUCLEAR RESONANCE
Valeriu, A., et al.
***Academia republicii populare Romîne, Institutul de fizica, studii şi cercetari de fizica,* v. 8, pp. 235–239, 1957**

A detailed description is given of a magnetometer which determines the stability of magnetic fields by measurement of nuclear resonance. (*NSA*, 1958)

76. MODULATION IN NUCLEAR PARAMAGNETIC RESONANCE
Pound, R. V.
***Review of Scientific Instruments*, v. 28, pp. 966–967, November 1957**

77. NUCLEAR RESONANCE TO REGULATE STRENGTH OF MAGNETIC FIELD
***Combustion, Boilerhouse and Nuclear Review*, v. 11, no. 12, pp. 563–564, December 1957**

Nuclear resonance techniques making use of properties of magnetic moment as developed in course of work of U. S. National Bureau of Standards, can be applied wherever strength of magnetic field must be closely regulated; description of experimental arrangement for determination of magnetic moment of proton. (*EI*, 1958)

78. APPLICATION OF NUCLEAR MAGNETIC RESONANCE TO FIELD MONITORING AND CONTROL IN MASS AND ALPHA ENERGY SPECTROMETRY
Sheffield, J. C. and White, F. A.
***Applied Spectroscopy*, v. 12, no. 1, pp. 12–16, 1958**

Nuclear magnetic resonance instrumentation was applied to mass spectrometers in several arrangements of magnet field stabilization and control, and as a monitor of the relative fields of paired magnet systems. Precise measurements of the magnetic field of an alpha spectrometer were made in determining alpha particle energies by monitoring the resonance frequency with an accurate frequency meter. (*PA*, 1958)

79. THE EFFICIENT USE OF A MAGNETIC FIELD IN HIGH FREQUENCY PROTON SOURCES
Gabovich, M. D.
***Zhurnal Tekhnicheskoy Fiziki*, v. 28, no. 4, pp. 872–880, 1958 (in Russian)**

The effect of a transverse magnetic field on a discharge supported by externally applied r.f. excitation is considered. It is shown that the presence of the field not only facilitates the introduction of power into the discharge region, but also leads to a more effective use of this power. The magnetic field introduces an anisotropy in the distribution of the ion current. This effect was used in a design of an ion source. Some experimental results obtained with this source are given. (*PA*, 1958)

80. FIELD HOMOGENIZING COILS FOR NUCLEAR SPIN RESONANCE INSTRUMENTATION
Golay, M. J. E.
***Review of Scientific Instruments*, v. 29, no. 4, pp. 313–315, April 1958**

Principles of operation and description of experimental coil stacks with 13 coil pairs, for second, third, and zonal fourth harmonics; preliminary results indicate that when 4-mm spin sample is used, this method can serve to reduce field inhomogeneities to less than one part in 10^8 with few sets of 13 current adjustments. (*EI*, 1958)

81. MEASUREMENTS AND STABILIZATION OF WEAK MAGNETIC FIELDS BASED ON MAGNETIC RESONANCE OF PROTONS
Zhernovoi, A. L., Egerov, Yu. S., and Latyshev, G. D.
***Pribory i Tekhnika Eksperimenta*, no. 5, pp. 73–75, September 1958 (in Russian)**

Descriptions are presented of measurements and stabilization of weak uniform magnetic fields starting at 5 oersteds. The order of precision in measurements of magnetic field intensity at the lower limits is $\sim 10^{-4}$ and increases with the increase of the field. Stabilization is fulfilled starting with 12 oersteds. Stabilization coefficient of the lower limit is 300. (*NSA*, 1959)

82. NEW METHOD FOR MEASURING UNIFORM AND NONUNIFORM MAGNETIC FIELDS BASED ON MAGNETIC RESONANCE OF PROTONS
Zhernovoi, A. I., Egerov, Yu. S., and Latyshev, G. D.
Pribory i Tekhnika Eksperimenta, no. 5, pp. 71–72, September 1958 (in Russian)

A measuring method is suggested for uniform and non-uniform magnetic fields based on the mutation of the total magnetic moments of protons. (*NSA*, 1959)

83. A NUCLEAR MAGNETOMETER
Waters, G. S. and Francis, P. D.
Journal of Scientific Instruments, v. 35, pp. 88–93, March 1958

The basic principles of the nuclear free precession magnetometer are briefly described, and full details are given of the coils, switching circuits and transistorized amplifying equipment of such a magnetometer. Accuracy of absolute measurement of the Earth's total field is plus or minus 10 μG, and even better when only relative measurements are required. Setting-up of the instrument, which requires no calibration, and taking a reading takes only a few seconds. (*NSA*, 1958)

84. PROTON SERVES AS PROBE IN MAGNETIC FIELD MEASUREMENT
Machine Design, v. 30, p. 10, September 4, 1958

85. UNIVERSAL NUCLEAR MAGNETOMETER
Denisov, Yu. N.
Pribory i Tekhnika Eksperimenta, no. 5, pp. 67–70, September 1958 (in Russian)

A universal apparatus for measuring constant magnetic fields based on the principle of nuclear resonance absorption is described. A range of 300 to 20,000 oersteds can be measured. The permissible inhomogeneity of magnetic fields in the transducer region is 4 to 5% of the measured value. The order of precision is $\pm 0.001\%$. The measurements are practically "point measurements" as the volume of the specimen, in which the nuclear absorption resonance is observed, varies at different ranges from 0.0002 to 0.01 cm^3. A four-mole aqueous solution of $Fe_2(SO_4)_3$ is used as a specimen. (*NSA*, 1959)

86. THE USE OF PROTON RESONANCE FOR THE MEASUREMENT OF NON-HOMOGENEOUS MAGNETIC FIELDS
Zhernovoi, A. I., Egerov, Yu. S., and Latyshev, G. D.
Inzhenerno-Fizicheskii Zhurnal, Akademii Nauk B.S.S.R., v. 1, no. 9, pp. 123–127, September 1958 (in Russian)

Nuclear resonance equipment is described which makes it possible to use the phenomenon of mutation of the resultant magnetic moment of protons of water for the measurement of non-homogeneous magnetic fields. The choice of optimal parameters is considered and the accuracy of measurement is estimated. (*NSA*, 1959)

87. RUBIDIUM VAPOR MAGNETOMETER –
Technical News Bulletin, pp. 234–235, December 1958

88. THE INSTALLATION FOR MEASURING AND STABILIZING MAGNETIC FIELDS IN SPECTROMETERS
Egerov, Ys. S., Seliverstov, D. M., Latyshev, G. D., and Zhernovoi, A. L.
Izvestiya Akadamii Nauk, SSSR, Seriya Fizicheskaya, v. 23, pp. 244–250, February 1959 (in Russian)

Descriptions are given of a universal spectrometer magnetic field meter and stabilizer operating on the principle of nuclear magnetic resonance. The installation is capable of measuring magnetic fields in the range 3 to 2500 gauss; stabilization is achieved at 10 to 2500 gauss. The considerable expansion of lower register range was accomplished by the preliminary magnetization of water which is used in the transducer. The order of measuring precision for magnetic fields over 100 gauss is $< 10^{-5}$. (*NSA*, 1959)

89. GYROMAGNETIC RATIO OF PROTON REDETERMINED
Driscoll, R. L. and Bender, P. L.
Electrical Engineering, v. 78, pp. 65–67, January 1959

90. MAGNETIC FIELD RECORDER WITH DISTANCE CONTROL
Gertsiger, L. N.
Pribory i Tekhnika Eksperimenta, no. 2, pp. 33–35, March–April 1959 (in Russian)

A measuring device is described for recording magnetic field intensities at 0.3–20 kilogauss, based on the principle of nuclear magnetic resonance. The device is controlled by a tube generator frequency by means of a seignetto-electric condenser. (*NSA*, 1959)

91. MEASUREMENT OF MAGNETIC FIELDS BY NUCLEAR RESONANCE: HALL PROBE
Kostyshyn, B. and Roshon, D. D.
***IRE, Proceedings of the*, v. 47, p. 451, March 1959**

92. MEASUREMENTS OF WEAK MAGNETIC FIELDS BY ELECTRON RESONANCE METHOD
Chirkov, A. K.
***Pribory i Tekhnika Eksperimenta*, no. 2, pp. 36–38, March–April 1959 (in Russian)**

The feasibility of using organic radicals and sodium solutions in liquid ammonia for measuring weak heterogeneous magnetic field intensity at 0.4–21 gauss is described. The order of error is 1–0.01%. (*NSA*, 1959)

III. MOVING COIL MAGNETOMETERS

A. Reports

93. A RECORDING MAGNETIC FLUXMETER
Berge, R. I. and Guderjahn, C. A.
Aeronautical Research Laboratory, Wright Air Development Center, Wright Patterson AFB, Ohio
WADC TR 54–50, January 1954 (AD 28,951)

A recording fluxmeter which employs integrators has been developed for the tracing of direct current magnetization curves. The current induced in a search coil surrounding a magnetic sample causes a sensitive galvanometer to deflect. Deflection of the galvanometer is detected by a balanced photocell bridge and photocell bridge output is amplified electronically. Negative feedback is applied to the galvanometer so as to reduce galvanometer deflections. The output voltage of the amplifier is the integral of the voltage induced in the search coil and is proportional to the magnetic flux in the sample. This voltage is applied to the Y axis of an XY recorder. (ASTIA)

94. MAGNETIC FIELD METER (DESIGN, APPLICATIONS, AND THEORY OF THE INSTRUMENT)
Kalashnikov, A. G.
Air Technical Intelligence Center, Wright Patterson AFB, Ohio
ATIC-262884, March 1, 1943, Translation F-TS-8938/V of *Zhurnal Tekhnicheskoy Fiziki*, v. 13, pp. 407–422, 1943 (AD 124,234)

This article describes the construction of an instrument for the vectorial measurement of the intensity of an inhomogeneous magnetic field, based on the measurement of the current produced in the circuit of a small rotating coil. Examples of the applications of the field magnetometer are given, as well as the elementary theory of the instrument and the technique of calculating the circuits. (ASTIA)

95. A MAGNETIC GRADIENT METER WITH A FLUXMETER
Kalashnikov, A. G.
Air Technical Intelligence Center, Wright Pattern AFB, Ohio
ATIC-262898, January 26, 1953, Translation F-TS-8952/V of *Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya*, no. 3–4, 1953 (AD 124,238)

Presentation is made of a new method of measuring the gradients of the geomagnetic field by the aid of rotating coils, measuring the variation of the magnetic flux through them by a sensitive fluxmeter. The theory of this method indicates that the readings of the fluxmeter are connected by simple relations with the values of the gradients of the Earth's magnetic field alone, and do not depend on its intensity. An experimental model of the instrument is described and data on its field tests are given, showing complete agreement between theory and experiment. (ASTIA)

96. A PERMALLOY STRIP MAGNETOMETER FOR FIELDS OF 5 TO 120 OERSTEDS

Gray, D. A.
Atomic Energy Research Establishment, Great Britain
AERE Report GP-R-1937, HD-2153, May 1956 (AD 111,441)

Details are given of the construction and performance of a magnetometer suitable for measuring fields of the order of 5 to 120 oersteds. The sensitive element is a thin permalloy strip on which a "backing coil" is wound. Direct current supplied to the backing coil is varied until the field produced by the coil exactly balances the field to be measured. This condition is detected by applying an a-c signal to the coil and noting the disappearance of even harmonics produced by the permalloy strip. An accuracy of ± 0.05 oersteds is obtained. (ASTIA)

97. MAGNETOMETER SYSTEM

Anderson, W. C.
Commerce Dept., Patent Office, Washington, D. C.
Patent No. 2,725,551, November 24, 1955

The magnetometer system includes: a source of alternating driving voltage; a pair of magnetometer bridge circuits, each of these circuits including a pair of magnetometer elements and each of the elements including a coil and a core; a means for coupling the alternating drive with each of the bridge circuits. The coils in one bridge circuit are wound opposite to those of the other. An indicator means is finally included, connected to the outputs of the pair of bridge circuits, which eliminates noise to fluctuation in the driving voltage. The indications are sensitive.

98. DYNAMIC AND STATIC MEASUREMENTS OF STRONGLY INHOMOGENEOUS MAGNETIC FIELDS

De Raad, B.
Delft, University of, *Dissertation*, 1958

Describes techniques and instruments for measuring the magnitude and flux density in strongly inhomogeneous and time-dependent magnetic fields of electromagnets. The methods used are based on the measurement of electromagnetic induction in a pickup coil and on the use of an electronic integrator. (*PA*, 1958)

99. DEVELOPMENT OF THE VIBRATING-COIL MAGNETOMETER AND ITS APPLICATION TO MAGNETITE

Smith, D. O.
Massachusetts Institute of Technology, Lab. for Insulation Research, Cambridge, Mass.
N5ori-07801, TR 102, November 1955 (AD 80,347)

A vibrating-coil magnetometer was used to measure the isothermal *M-H* curves of magnetite at atmospheric pressure in the principal crystallographic directions from room temperature to the Curie point. Near the Curie point, the magnetizing field required to create a single domain was less than 100 amp/m which provides an unambiguous experimental determination of the spontaneous magnetization in this critical region. (ASTIA)

100. MICROINHOMOGENEITIES IN MAGNETIC FIELDS

Brown, H. H., Jr. and Bitter, F.
Massachusettes Institute of Technology, Research Lab. of Electronics, Cambridge, Mass.
September 4, 1956 (AD 122,935)
Reprint from *Review of Scientific Instruments*, v. 27, pp. 1009–1012, December 1956

Small variations in the fields of magnets, caused by structures or domains in the pole faces, were investigated by moving a small coil in a circular path. It was found that for a given pole face the variations in the field were all about the same size, and decreased exponentially from the pole face. None of the materials tested as pole faces produced strikingly better fields than another. (ASTIA)

101. MAGNETOMETER

Leavitt, M. A.
U. S. Atomic Energy Commission
U. S. Patent 2,861,242, November 18, 1958

A magnetometer is described as a device which accurately indicates the polarity and intensity of a magnetic field. The main feature of the invention is a unique probe construction in combination with a magnetic field detector system. The probe comprises two coils connected in series opposition for energization with an a-c voltage. The voltage induced in a third coil on the probe, a pick-up coil, is distorted by the presence of an external field to produce even harmonic voltages. A controlled d-c current is passed through the energized coils to counter the distortion and reduce the even harmonic

content to a null. When the null point is reached, the d-c current is a measure of the external magnetic field strength, and the phase of the pickup coil voltage indicates the field polarity. (*NSA*, 1959)

B. Periodicals

102. THE MEASUREMENT OF SMALL FORCES BY MEANS OF A MOVING COIL METER WITH AN APPLICATION TO MAGNETIC SUSCEPTIBILITY MEASUREMENTS

Poulis, J. A., Poldervaart, L. J., and Teunissen, P.
***Applied Science Research*, B., v. 6, no. 1–2, pp. 124–128, 1956**

A method is described for the measurements of small forces (10^{-5}–10^{-3} newton) on a sample weighing a few grams. This sample is placed on a bar which is fixed on the turning coil of an ordinary switchboard current meter. The force on the sample can be compensated by the Lorentz force on the current through the coil. This method avoids a great many of the usual constructional difficulties of such apparatus and leads to a robust instrument which is easy to handle and to automatize, thus being of interest for use outside the laboratory. This possibility in particular led to the choice of a magnetic susceptibility balance as an example. For magnets of field strength up to 20,000 oersteds the precision obtained for the measured susceptibility amounts to one tenth of a per cent. (*PA*, 1957)

103. VIBRATING SAMPLE MAGNETOMETER

Foner, S.
***Review of Scientific Instruments*, v. 27, no. 7, p. 548, July 1956**

Describes a magnetometer based on the detection of the dipole field from an oscillating magnetic sample placed in a uniform magnetic field. Positioning of the detection coils is discussed and a null detector described. Measurements of the magnetic moment of a 1.2-mm-diam. nickel sphere have been made to 0.5%. (*PA*, 1957)

104. THE MEASUREMENT OF THE MAGNETIC CHARACTERISTICS OF ROCKS (UNIVERSAL TORSION MAGNETOMETER METHOD)

Kalashnikov, A. G.
***Doklady Akademiya Nauuk SSSR*, v. 110, no. 5, pp. 776–779, 1956 (in Russian)**

A cubical specimen of the rock is placed on one arm of a torsion balance. Two pairs of coils with their planes vertical and parallel to the balance arm, are set up on opposite sides of the specimen. Current supplies to the two pairs of coils are independent of one another, one pair is arranged as a Helmholtz uniform field arrangement and the other pair is used to provide a linearly variable field. The apparatus allows the magnetic susceptibility, residual magnetization and coercive force of the specimen to be determined for fields ranging from 0.5 to 5 oersteds. The theory of the instrument is given. (*PA*, 1957)

105. CONTINUOUSLY INDICATING PRECISION MAGNETOMETER

Green, G. W., Hanna, R. C., and Waring, S.
***Review of Scientific Instruments*, v. 28, no. 1, pp. 4–8, January 1957**

A flat coil is suspended in a magnetic field so that in equilibrium it is coplanar with the field and can oscillate about an axis in the plane of the coil perpendicular to the field. When an alternating current is passed through the coil the system behaves as an inductance in series with a condenser of capacity inversely proportional to the square of the magnetic field. The principle has been applied to the measurement of magnetic field. The instrument is capable of a precision of one part in 10^2 with simple auxiliary apparatus. The application to a particle analyzing magnet is described. With some elaboration the magnetic field can be measured and stabilized to one part in 10^4 in the range 1–12 kilogauss. (*PA*, 1957)

106. A DEVICE FOR STUDYING MAGNETIC ANISOTROPY

Timofeev, B. B.
***Elektrichestvo*, no. 5, pp. 72–74, 1957 (in Russian)**

Based on an observation previously made by the author, a vertical probe is applied to the surface of a large slab of material under investigation. By this means an alternating current is fed into the material. Attached to the vertical rod by a loose collar is a small coil in the form of a sector and containing a large number of turns. The connections to the coil are taken to an amplifier on the Y-plates of a cathode-ray oscilloscope. The X-deflection has a voltage proportional to the current in the probe. It

will be observed from the screen of the cathode-ray oscilloscope when the net excitation in the sector coil is zero. An appendix analyzes the situation and shows how the method defines the regions of different permeability and the lines along which the maxima and minima occur. To overcome the lack of uniformity of the surface an improved version is also described in which four sector coils, each covering 90 deg, are used. (*PA*, 1958)

107. COILS FOR MAGNETIC FIELDS
Clarke, G. M.
Electronic and Radio Engineer, v. 35, pp. 298–306, 340–344, August–September 1958

108. FURTHER DEVELOPMENT OF THE VIBRATING COIL MAGNETOMETER
Dwight, K., et al.
Journal of Applied Physics, v. 29, pp.491–492, March 1958

109. MAGNETIC MEASUREMENTS OF THE CORNELL ALTERNATE GRADIENT SYNCHROTRON
Malamud, E. and Silverman, A.
Nuclear Instruments and Methods, v. 4, pp. 67–78, March 1959

A brief description of the synchrotron magnet is followed by a summary of the factors leading to a choice of field gradient, and a description of the pole tip design. Measurements of the synchrotron field gradients at low, medium, and high fields are described. The medium and high field gradients are measured using a rotating coil magnetometer. The gradients at injection time were determined by two independent methods: (1) using the electron beam itself to find the radial and vertical focal points; and (2) using peaking strips to make zero time measurements. The results of these measurements and also the determination of the magnetic lens boundaries are summarized. (*NSA*, 1959)

IV. AIRBORNE MAGNETOMETERS FOR MEASURING TERRESTRIAL AND EXTRATERRESTRIAL MAGNETIC FIELDS

A. Reports

110. INSTRUMENT FOR MEASURING THE GRADIENT OF THE EARTH'S MAGNETIC FIELD FROM AN AIRPLANE
Gnevushev, V. and Pechernikov, V.
Air Technical Intelligence Center, Wright Patterson AFB, Ohio
ATIC-293911, 1957, Translation F-TS-10007/V of *Trudy Glavnoi Geofizicheskoi Observatorii*, no. 5, pp. 36–42, 1956 (AD 140,548)

111. AIRBORNE MAGNETOMETERS
Logachev, A. A.
Air Technical Intelligence Center, Wright Patterson AFB, Ohio
ATIC-293925, 1957, Translation F-TS-9087/V of *Aeromagnetometry*, pp. 86–112, 1951 (AD 137,547)

This report deals with: airborne magnetometers, the airborne induction Z-magnetometer, the induction aerial T-magnetometer, and aerial magnetometers with magnetically saturated sensitive elements. (ASTIA)

112. NOL VECTOR AIRBORNE MAGNETOMETER TYPES 2A AND 2B
Ions, H. R. and Schonstedt, E. O.
Naval Ordnance Laboratory, White Oaks, Md.
Report 1187, November 15, 1954 (AD 64,211)

113. UTILIZATION OF A MOON ROCKET SYSTEM FOR MEASUREMENT OF THE LUNAR MAGNETIC FIELD
Vestine, E. H.
RAND Corporation, Santa Monica, Calif.
AF 33(038)6413, Project RAND, RM 1933, July 9, 1957 (AD 133,008)

A review is presented of current research regarding possible measurements of the Moon's magnetic field by 3- to 5-lb magnetometer landed on the Moon by a Moon-rocket. (ASTIA)

114. A SATURABLE INDUCTOR MAGNETOMETER
Wilson, A.
Royal Aircraft Establishment, Great Britain
TN TD 6, JSRP Control no. 560528, April 1956
(AD 100,451)

A saturable inductor-type of magnetometer is described which was developed for measuring the attitude of a missile relative to the Earth's magnetic field. The system is comprised of sensing elements, an oscillator to energize the sensing elements, a frequency selective amplifier, and a rectifier. The sensing element consists of a transformer wound on a ceramic tube, having 2 primary windings wound in opposition and 1 secondary winding containing many more turns than the primaries. The core of each primary is a strand of high-permeability wire. An energizing current of 11 ma (rms) is passed through the primaries and in the absence of any external magnetic field the flux cancels and no voltage is induced in the secondary winding. (ASTIA)

115. PHOTOELECTRIC MEASUREMENTS OF SOLAR MAGNETIC FIELDS
Kiepenheuer, K. O.
Yerkes Observatory, Williams Bay, Wis.
N9onr 97100, October 21, 1952
Reprint from *The Astrophysical Journal*, v. 117, pp. 447–453, May 1953

B. Books

116. EXPLORING THE ATMOSPHERE WITH A SATELLITE-BORNE MAGNETOMETER
Vestine, E. H.
"Scientific Uses of Earth Satellites," Van Allen, J. A., ed., pp. 198–214
University of Michigan Press, Ann Arbor, 1956

Summary of explorations for consideration. Various electric current systems suggested for explaining the known geomagnetic variations at ground level are briefly described. (*Literature of Space Science and Exploration*)

117. SPECTROSCOPIC MEASUREMENTS OF MAGNETIC FIELDS ON THE SUN
Kluber, H. von
"Vistas in Astronomy," Beer, A., ed., v. 1, pp. 751–756
Pergamon Press, London, 1955

The various methods employed for the measurement of solar magnetic fields, on the basis of the Zeeman effect in the Frauenhofer spectrum, are described. The optical arrangements are discussed and illustrated. (*PA*, 1957)

C. Periodicals

118. HIGH ALTITUDE MEASUREMENTS OF THE EARTH'S MAGNETIC FIELD WITH A PROTON PRECISION MAGNETOMETER
Cahill, L. J. and Van Allen, J. A.
***Journal of Geophysical Research*, v. 61, no. 3, pp. 547–558, September 1956**

The instrumentation, including the magnetometerhead, amplifier, and radio telemetering transmitter, was carried to 100,000-ft altitude by a plastic balloon. Satisfactory signals were received until 2.5 hr after launching at which time the balloon was near the radio horizon, approximately 200 mi from the ground station.

119. A SOLAR MAGNETOGRAPH
Beggs, D. W. and Kluber, H. von
***Nature*, v. 178, p. 1412, December 22, 1956**

120. INSTRUMENTS FOR SATELLITES
***Journal of the Franklin Institute*, v. 264, pp. 258–259, September 1957**

A description is given of the Varian magnetometer, a device which measures the Earth's magnetic field, and which will be one of the instruments carried in the Earth satellite. (*Literature of Space Science and Exploration*)

121. MAGNETIC FIELD OF VENUS
Narayana, J. V.
***Proceedings of the Indian Scientific Congress*, Part IV, p. 50, 1957**

122. MAGNETOMETER FOR THE SATELLITE
Bloom, A. L. and Johnson, L. E.
***Electronic Industry and Tele-Tech*, v. 16, pp. 76–78, 148–158, August 1957**

The characteristic frequency of precessing protons in a weak magnetic field can serve as a measure of the Earth's field in space. Data from rocket-borne magnetometers has been extrapolated to produce a tentative design for a satellite magnetometer. (*Literature of Space Science and Exploration*)

123. ON THE POSSIBILITY OF MEASURING INTERSTELLAR MAGNETIC FIELDS BY 21 CM ZEEMAN SPLITTING
Bolton, J. G. and Wild, J. P.
Astrophysical Journal, v. 125, no. 1, p. 296, January 1957

124. RECENT IMPROVEMENTS IN GEOMAGNETIC MEASUREMENTS
Thellier, E.
Journal de la Physique et le Radium, v. 18, no. 1, pp. 9–10, January 1957 (in French)

125. SATELLITE MAGNETOMETER TO MEASURE EARTH'S FIELD
Radio and TV News, v. 58, p. 158, September 1957

126. A THREE COMPONENT AIRBORNE MAGNETOMETER
Serson, P. H., Mack, S. Z., and Whitman, K.
Publication of the Dominion Observatory, Ottawa, v. 19, no. 2, pp. 15–97, 1957

The magnetometer described contains three orthogonal magnetic detectors of the saturated transformer type. It is mechanically linked to a gyro-stabilized platform which is maintained horizontal. The system acts basically as a pendulum with a 6-min period, and the accuracy of the platform is 2 or 3 min of arc under normal survey conditions. Signals from the magnetometer are fed into an analog computer which displays continuously the declination in degrees and the horizontal and vertical field components in gauss. The accuracy of measurements is estimated to be 0.1 deg in declination and 20 gamma in the other components. Sources of error in survey operations are discussed and it is concluded that the probable error of a survey observation as plotted on a chart is about 100 gamma in any component and is principally due to errors in navigation and plotting. (*PA*, 1958)

127. TRACKING DOWN THE SYNTHETIC SATELLITE. U.S. NAVY PROJECT VANGUARD
Canadian Mining Journal, v. 78, p. 82, July 1957

Describes expected use of a Varian magnetometer, a device which measures the Earth's magnetic field. A Varian magnetometer, to be carried in the Vanguard satellite, will provide a record of the Earth's magnetic field above the ionosphere and is expected to answer many questions concerning magnetic disturbances. (*Literature of Space Science and Exploration*)

128. THE VARIABILITY OF THE (SUN'S) MAGNETIC FIELD AND THE HEATING OF THE SOLAR ATMOSPHERE
Ivanchuk, V. I.
Doklady Akademiya Nauk SSSR, v. 117, no. 4, pp. 589–92, 1957 (in Russian)

Three different (approximate) methods all lead to an estimate of the mean energy of the solar magnetic field of 10^{37} ergs.

129. CAN MEASURE MAGNETISM IN EARTH AND OUTER SPACE
Machine Design, v. 30, Part 3, no. 16, p. 36, August 7, 1958

130. INTERPLANETARY MAGNETIC FIELD AND ITS CONTROL OF COSMIC-RAY VARIATIONS
Piddington, J. H.
The Physical Review, v. 112, p. 589ff, October 1958

131. RESULTS OF AIRBORNE MAGNETOMETER PROFILE FROM BROWNSVILLE, TEXAS TO GUATEMALA CITY
Agocs, W. B.
Geophysics, v. 23, pp. 726–737, October 1958

132. TOMORROW'S NEW HORIZONS? MAGNETOHYDRODYNAMICS
Smith, L. P. and Patrick, R. M.
Electronics (English Edition), v. 31, pp. 17–18, January 24, 1958

133. INVESTIGATION OF THE EQUATORIAL ELECTROJET BY ROCKET MAGNETOMETER
Journal of Geophysical Research, v. 64, no. 6, pp. 489–503, June 1959

134. MAGNETOMETER FOR SPACE EXPLORING ROCKETS: ABSTRACT
Franken, P. A.
Journal of the Franklin Institute, v. 267, pp. 184–185, February 1959